A PRELIMINARY REPORT ON THE SEASONAL MIGRATIONS OF INSECTS

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Certain of the broader aspects of insect migrations as they occur in the Northeastern United States were presented eleven years ago (Sci. Monthly, 3: Sept., 1916, 227–240 and Harper's Magazine, 131: Sept., 1915, 609–618). Since that time more intensive studies have been in progress. They have been directed toward a discovery of our little known migratory species, and also toward an analysis of the factors operative in producing the phenomena observed. We will first review the conceptions advanced in 1915. It was suggested that apparently occasional movements of certain insects, such as dragonfly migrations for example, were really regular seasonal events, and followed constant definite directions from year to year. It was also suggested that a greater number of orders and species of insects than had hitherto been shown were also regular migrants with the seasons; and notwithstanding dispersal movements on a large scale which affect the Rocky Mountain locust and other forms, there was actually a regular and ascertainable north-to-south and south-to-north movement in our hemisphere and territory.

This conception as applied to certain dragonflies was then supported by data gathered in the field and by certain sparse records in our North American literature. It was also supported by a detailed tabulation of all authentic European records—a total of thirty-four then discoverable in the literature. Since that time further records have appeared. Dr. Raymond Osburn has reported a Connecticut flight (Jour. N. Y. Entom. Soc., 1916, vol. 24, 90–92) and Dr. R. Heber Howe, Jr., announces observations in Massachusetts (Proc. Boston Soc. Nat. Hist., vol. 36, No. 2, III). With both observers the flights were

autumnal and moved southward. It was also predicted that spring northward flights would be observed in this country, *even though none were known,* if we except the possibly inconclusive observations by Bradford Torrey on the Massachusetts coast (Amer. Nat., vol. 14, pp. 132–133 and p. 594). Such spring and early summer flights have since been studied by the writer, all consistently moving northward or along coast-lines in accordance with that direction. A total of more than 60 dragonfly flights have been observed, including both seasons of the year.

An elaborate tabulation of data at all comparable with bird-migration records has long been lacking. Nor have the intervening eleven years offered other than inconsiderable progress in this direction. Experimental studies in fields, quite apart from migration phenomena in fact, have offered some of the more significant suggestions of recent years. Also notable studies of Diptera migrations in Africa should be noted, and will be referred to again in their proper place.

Detailed records, then, it has been the writer's attempt to supply. They are necessarily limited to quite local territory. Five stations, among others, were chosen along the eastern Atlantic coast. No. 1 is located at Long Beach, L. I., about mid-way of its length of eight and one-half miles of shore; No. 2 on the same beach about three miles to the westward, and No. 3 on the Far Rockaway shore almost diagonally northwestward from the western extremity of Long Beach. No. 4 is located at Norton's Point, the western tip of Coney Island, while No. 5 is located at Longport, N. J., about one hundred miles farther south on the shore of Great Egg Inlet. At all these points records have been made. The most time has been spent at Stations 1 and 2 which accounts for the fuller records from these points. Here as well as elsewhere movements of Odonata have been tabulated, also those of Lepidoptera, Hymenoptera, Coleoptera and Diptera. Plant and other ecological relationships have also been considered in these localities.

Our most widely known insect migrant, *Anosia plexippus,* could not be ignored. In fact considerable attention has been given

to this butterfly. Its autumn behavior offers, in the first place, excellent material for study. Moreover recent literature has revealed rather striking misconceptions regarding these autumnal aspects of its life-history. Considerably over sixty flights have been observed. Its spring appearance also is revealed to us in such sparse data that careful observations were made. Specimens have been taken in various years; the relative proportion of the sexes determined; their microscopic appearance; their behavior as they enter our territory and the characteristics of the subsequent generation.

Other Lepidoptera migrants of autumn and spring have been tabulated, an elaboration of the suggestions made nine years ago and supported at that time by brief data only (Amer. Mus. Jour., vol. 17, No. 1, pp. 32–40). Over forty such flights have been detailed.

Special attention has been given to the Diptera exclusive of the Culicidæ. This is virtually an untouched field. For little is offered in the literature concerning such phenomena in North America excepting accounts of wandering *Sciara congregata* larvae and records of flies found in out-of-the-way places (Mr. S. C. Ball, Pap. Dept. Mar. Biol. Wash., 12, 1918, pp. 193–212). Only a brief description by Scudder of a moving column of *Ilythea spilota* along the New Hampshire coast offers any real picture of a dipterous migration as conceived by the writer (Psyche, vol. 5, No. 172–174, pp. 402–403). European literature is hardly more satisfactory. Only notes of what appeared to the observers as swarmings of Syrphids are noted, interspersed with several brief accounts of flights along the British coast during the notable visitation of the year 1864. Professor Eimer's brief account of Syrphids travelling southwestward in autumn when they companioned a dragonfly swarm is significant; as also, Dr. Roubaud's studies of the seasonal migrations of the Tsetse fly in Africa. He found that *Glossina morsitans* and other species performed annual movements in Dahomey, and of undoubtedly considerable extent, in direct response to the meteorological conditions affecting them and their environment.

What then does the writer mean by a Diptera migration? Care has been taken to rule out purely ephemeral movements due to brief or accidental reactions occurring in regions where flies congregate. On the other hand true migrations, but of a probably delimited character, may be seen in the case of certain small flies like the kelp fly. I have seen this species, *Fucellia maritima,* moving along in swarms of many hundreds, or even thousands, through localities by the seashore where its habitat is made. Quite probably Scudder's *Ilythea* flight was of this nature.

More significant dipterous phenomena occur. Nothing less than veritable streams of various flies sometimes appear moving more or less in unison and passing in hundreds, which readily total into thousands, during the several hours through which such a seasonal procession usually persists. They occur every year and more than once a year, usually at a certain definite period. Often the flight consists mostly of moderate-sized species like *Cochliomyia macellaria* Fabr., *Phormia regina* Meig., and others intermingled with fewer larger forms like *Calliphora erythrocephala* Meig. Syrphids are in the great majority only rarely. So the migratory trends of *Eristalis tenax* Linné stressed on the map are not emphasized because of the necessarily profuse numbers present. It is readily identified on the wing, is a common participant, and can be perceived for considerable distances winging far out over the water-barriers or approaching the shore after such a passage. So it serves to define certain otherwise conjectural air-lanes of travel. Since 1915 fifty such Diptera movements have been observed, all autumnal and moving westward on Long Island (except for the over-water flights noted) and southwest in New Jersey.

Certain species are identified from year to year. They are taken with negligible exceptions only when active in full driving flight as participants in definite migratory behavior. *Cochliomyia macellaria* has been taken at either Stations 1 or 2 in a total of five different years, at Station 5 in one year; *Stomoxys calcitrans* Linné at either Stations 1 or 2 in a total of six different years, at Station 5 in one year; *Eristalis tenax* Linné has

been taken at either Stations 1 or 2 in a total of five different years, at Station 4 in one year, at Station 5 in six different flights of the same year. Other species show a similar constancy. Also other families beside the Muscidæ and Syrphidæ are represented which justify the statement that a migratory tendency is widely distributed in the Diptera, and involves many individuals and species in annual movements of undetermined extent.

No claim is made that individuals moving southwest at Longport, N. J., one hundred miles south of Long Island, are the same ones that passed through this locality. An identity of species may be deceptive. On the other hand Dr. Howard has said, "and if it (*Musca domestica* Linné) were obliged to fly great distances the writer has little doubt of its ability to do so." Incidentally this species has been taken at either Stations 1 or 2 in a total of five different years participating in apparent migrational flight. Only marking experiments however will prove decisive. The accurate identification of all species I owe to the kindness of Mr. Charles W. Johnson who has gone over the hundreds of specimens taken.

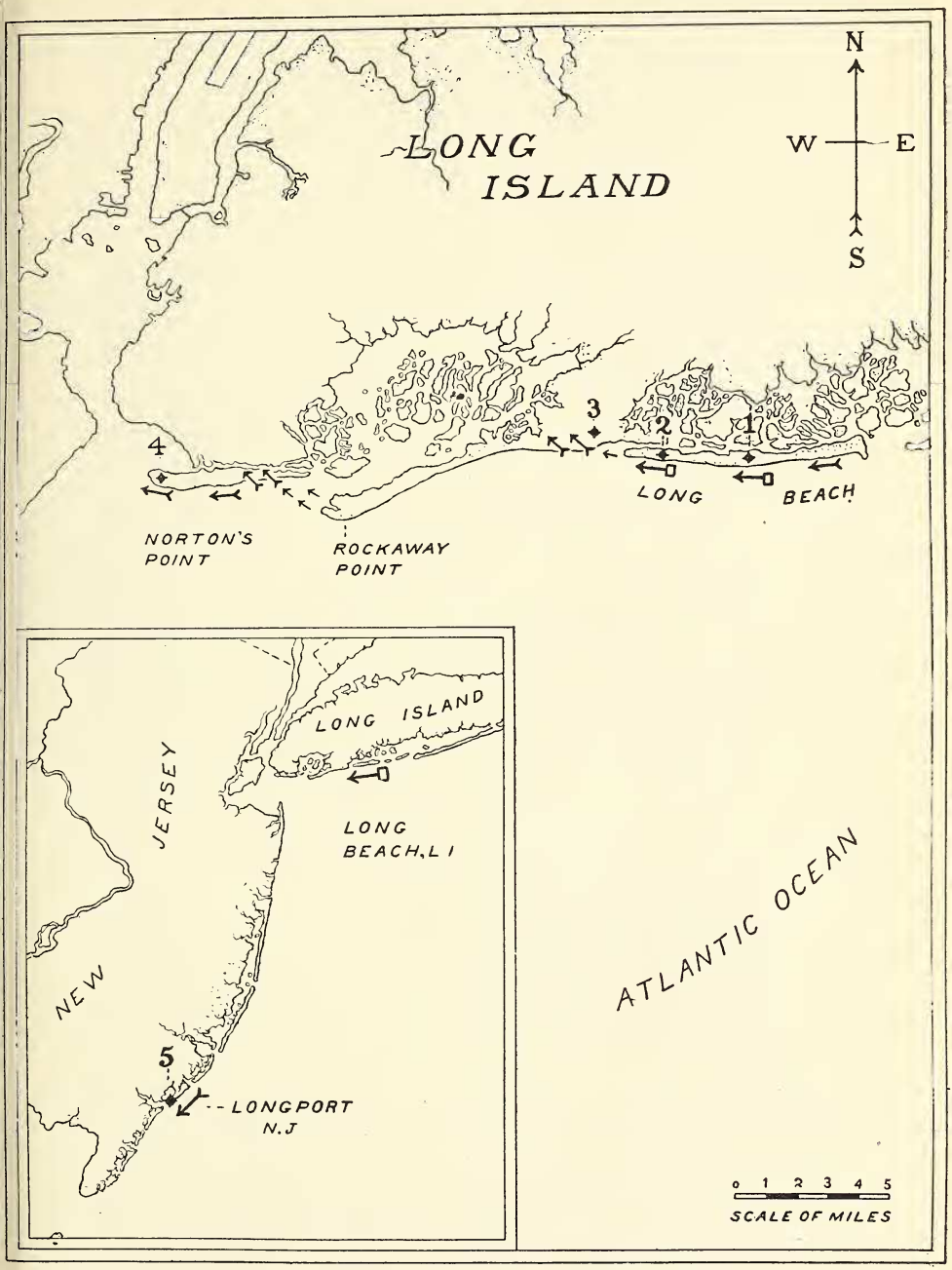
It has become possible to map out broadly the seasonal periods when various orders became migratory; also by a study of meteorological conditions it is often possible to predict the occurrence of flights early in the morning of the days when they occur. Spring behavior in all orders has received less attention. This is partly due to weather conditions in recent years and also to the writer's abbreviated opportunities at that time. No conclusive records of spring Diptera migrations have been obtained; it seems inevitable they should occur.

This report would be incomplete if it failed to acknowledge the unfailing encouragement offered to the writer, during the progress of these studies, by Mr. Andrew J. Mutchler of the American Museum of Natural History.

EXPLANATION OF PLATE XXIV

AUTUMN MIGRATIONS OF DIPTERA AND OBSERVATION STATIONS

Cube-tipped arrows illustrate the annual migrations of *Cochliomyia macellaria, Eristalis tenax* and other species. Feathered arrows show occasionally observed flights (probably annual) of *Eristalis tenax* and other species; *unfeathered* arrows the presumable earlier steps in flights over the water from points of land southeastward. Similar behavior is exhibited by *Anosia plexippus* and certain other Lepidoptera and Odonata.



MIGRATIONS OF DIPTERA